

PB 199460-D

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FOR APPLICATIONS TECHNOLOGY SATELLITE
PROGRAM (NASA) 31 Mar. 1971 12 p CSCL 22A

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NATIONAL TECHNICAL INFORMATION SERVICE

U.S. DEPARTMENT OF COMMERCE

DRAFT

March 31, 1971

APPLICATIONS TECHNOLOGY SATELLITE PROGRAM

FOR

ENVIRONMENTAL STATEMENT

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

8199460-D

ENVIRONMENTAL IMPACT STATEMENT

ATS PROGRAM

1. Program Description and Objectives

The Applications Technology Satellite (ATS) Program Objectives include flight test of technology and experiments relating to the useful applications of space, making use of satellites in synchronous orbit. Experiments are carried in the disciplines of communications, navigation, meteorology, data collection (including data from small unattended remote stations such as buoys, seismology and hydrology monitors, etc.), geodesy, and scientific experiments to define the environment at synchronous orbit, and to monitor emissions from the sun.

To achieve these objectives, five spacecraft have been launched and two more are planned. Of the five launched, three (ATS 1, 3 and 5) are still in orbit and will remain at synchronous altitude. These were launched in 1966, 1967, and 1969 respectively. The two planned launches, ATS-F and -G will be flown in 1973 and 1975.

ATS 1 and 3 were placed in orbit using the ATLAS-AGENA D (SLV-3/S-013) launch vehicle and a kick motor using JPL-540 propellant. ATS 5 was placed in orbit using the Atlas-Centaur launch vehicle and the same kick motor.

The sequence of operations and hardware to be used for the ATS-F and -G launches are as follows:

General Missions Description

The ATS-F and -G launches, in 1973 and 1975 will follow similar launch patterns.

ATS-F will be placed into a nominally synchronous equatorial circular (SEC) orbit, initially above the United States at 94 degrees $\pm 4^\circ$ west longitude. It is presently planned to launch the spacecraft from the Eastern Test Range aboard a Titan III C at an azimuth of about 93 degrees East. In order to achieve a desired sunrise injection for synchronous orbit, the launch will occur about 0100 hours. The launch window can be extended from ± 0.5 hours nominal to ± 1.25 hours maximum by utilizing the $\pm 11^\circ$ pitch offset command for the earth sensor. This ensures that earth acquisition will occur during the roll scan maneuver around the sun line.

At the second equatorial crossing the the parking orbit, the Transtage (Stage III) will be ignited for about 310 seconds to inject the spacecraft/Transtage into a transfer orbit with apogee at the synchronous orbit altitude of 19,323 n. mi. by the self contained on-board flight programmer. The transfer orbit inclination is reduced to 26.36 degrees to maximize the payload capability in the final synchronous circular (SEC) orbit.

During the 5.3 hour coast in the transfer orbit, the Transtage will position the orientation of the spacecraft so the thermal control louvers will be pointed away from the sun. This will ensure proper operation of the ATS thermal control system during the transfer orbit. The X-axis of the ATS will be aligned with the sun line to enhance solar power generation by the stowed solar panels since elements of the Attitude Control Subsystem and the Telemetry and Command Subsystem (T&C) will be powered during the launch phase.

Following the coast to synchronous altitude, the Transtage will thrust for about 120 seconds to inject the spacecraft into a nominal synchronous equatorial circular orbit. Separation of the spacecraft from the Transtage is automatically triggered following injection by the Transtage Flight programmer, with a backup capability provided by ground command from Rosman via the ATS command system. Following separation, the Transtage is reoriented to perform a retro maneuver to remove it from the ATS orbit path and preclude any subsequent interference with ATS orbit operations.

Environmental Impact

The use of proven hardware and techniques, coupled with studies, analysis and experience gained over a decade of space flight, provide the basis in the following assessment of the ATS Program, indicating that no significant adverse impact on the environment will occur.

Atmosphere

The small size of the spacecraft reaction control thrusters, together with the fact that they are used at 22,300 miles altitude, leads to the conclusion that their terrestrial result will be insignificant.

A relatively minute potential impact on the environment is associated with the spacecraft on-board attitude control and stationkeeping thrusters. ATS 1, 3 and 5 employed a gaseous nitrogen spin-up system which contained about 7 pounds of N₂ which was discharged

into the free space. ATS 1 and ATS 3 also contained hydrogen peroxide attitude control subsystems of about 60 and 30 pounds respectively which were expended into space. ATS 3 also contained a hydrazine propulsion system of some 17 pounds, about half of which has been expended. ATS 1, 3 and 5 carried experimental resistojets which discharged several pounds of ammonia into space. In addition to a 40 pound hydrazine system, ATS 5 carries a cesium ion microthruster of about 10 pounds and a subliming solid thruster system which expels minute amounts of an ammonia compound into space.

The ATS-F and -G spacecraft will also employ hydrazine thrusters. ATS-F will also carry a cesium ion thruster of approximately the same size.

The launch vehicles currently used by NASA for automated science and applications missions range in size from the Scout to the Titan III C. The propellant combinations used in their stages include solids, LOX/Hydrogen, LOX/RP-1, IRFNA/UDMH, and N_2O_4 . A total of approximately 20 of these vehicles are launched annually from four launch sites: Wallops Island, Virginia; Western Test Range, California; Cape Kennedy, Florida; and the San Marco Platform in the Indian Ocean off Kenya.

These small and medium class launch vehicles are considerably smaller than the Saturn class, which is discussed in the Apollo Program Environmental Statement and it is concluded that no detrimental environmental impact results from these launches.

The ATS-F and -G missions will be launched into synchronous orbit from Cape Kennedy, Florida in 1973 and 1975 utilizing a Titan III C launch vehicle.

Radiation: Minute amounts of low energy level radioactive materials will be used in some of the ATS experiments. Special provisions are made for these and safety reviews are made by specialists from NASA, AEC and other agencies. Materials are packaged, shielded and handled in accordance with AEC standards and procedures so they will not cause any environmental impact.

Alternatives: Alternative spacecraft hardware configurations to reduce environmental effects were reviewed and the conclusions drawn was that insignificant amounts of on-board fuel and other possible contaminants were carried.

Relationship Between Short-Term Uses of the Environmental and Enhancement of Long-Term Productivity

It is expected that local short-term use of the environment in this program will contribute to the enhancement of long-term productivity because of the knowledge which has and will continue to accrue from the ATS Experiments.

Irreversible/Irretrievable Commitments of Natural Resources

No depletion of natural resources will result from the ATS Program.

Benefits

As indicated in the first section of this statement, a number of experiments and scientific observations of direct benefit to mankind have been and are to be conducted. Initial development of technology for meteorological observation from synchronous orbit has been conducted aboard ATS flights 1 and 3. Sensors have been spin scan cameras operating in the visual regions of the spectrum. Surface resolution is 1.9 nautical miles. Coverage is the entire visible Earth reviewed from synchronous altitude. The ATS 1 camera presented a monochrome picture, the ATS 3 camera, a color picture. One picture could be taken every 20 minutes in the case of ATS 1 and every 24 minutes in the case of ATS 3.

Experimentation with ATS 1 and 3 has been concentrated on extensive observations of severe weather phenomena such as tornadoes and hurricanes. In early 1968, ATS 3 was moved from its original location over the Atlantic Ocean (47 degrees W longitude) to a mid-U.S. longitude for a cooperative experiment with NOAA during the 1968 tornado season. In this experiment, ATS 3 continuously photographed the Earth in daylight during times of high tornado probability predicted by NOAA, that is during the "tornado watches." During the period from 6 March through 18 May, there were 22 tornado watches, containing 14 days during which tornadoes actually occurred.

A total of 870 ATS 3 pictures were made during this experiment. The pictures have made a considerable contribution to the detailed understanding of tornado formation. We have continued the activity through the 1969 and 1970 tornado season. Today our efforts involve after-the-fact analyses leading toward understanding the phenomenon. In future operations, however, we feel that such real-time data can be used to reduce the uncertainty in predicting the occurrence of tornadoes, as well as in predicting their paths.

Chart (SA 69-381) shows a picture taken by ATS 3 during such a "tornado watch" on 19 April 1968, a day of great tornado activity. One of the tornadoes generated was particularly tragic because it struck Greenwood, Arkansas, at 3:12 P.M. CST, killing 14 persons, injuring 270, and causing extensive damage to the town. The ATS-3 pictures shown in the chart were taken about the same time. The chart includes a picture of the northern half of the Western Hemisphere as taken from the satellite. An electronically enlarged section, showing the cloud structure over the Central United States and Northern Mexico, is also included together with a schematic drawing showing a characteristic textbook tornado situation. One can clearly see the similarity between the schematic drawing and the pictures showing an actual situation.

ATS 3 pictures covering only a part of the visible disk of the Earth can be taken ten or twelve minutes apart and, when viewed in a rapid succession "movie" fashion, show features which are impossible to detect and understand in single static observations.

When the tornado season was past its peak, ATS 3 was moved back to its position over the Atlantic Ocean for a joint experiment with NOAA involving a "hurricane watch" analogous to the tornado watch. This has extended through the 1968, 1969 and 1970 hurricane seasons, and has provided a powerful tool for observation of the motion and characteristics of individual hurricanes.

Some very important observations of major storms were made with ATS 1 which is still performing well over the Pacific Ocean. The next chart (SA 69-382) illustrates how the ATS capability to take pictures in rapid succession contributes to our understanding of storm formation. In this case, the wind direction and speed which were derived from ATS 1 cloud motion data are superimposed on conventional photographic mosaics of the storm which were made from NOAA pictures. Of particular interest is the influence of the north-flowing winds originating south of the equatorial regions. These analyses have shown for the first time the existence of definite breaks in the inter-tropical convergence zone in this area, indicating that winds from the Southern Hemisphere influence the formation of storm centers in the Northern Pacific. This means that continued surveillance of the tropics and the winds passing through the inter-tropical convergence zone may assist in the more effective prediction of major storms in the Northern Hemisphere. The near real-time availability of wind data made possible by ATS type photos is an extremely important tool for such predictions.

Contributions from ATS 1 and 3, to our understanding of the weather, have been so valuable that NASA and NOAA have agreed to use the meteorological sensors on ATS 1 and 3 in a quasi-operational manner,

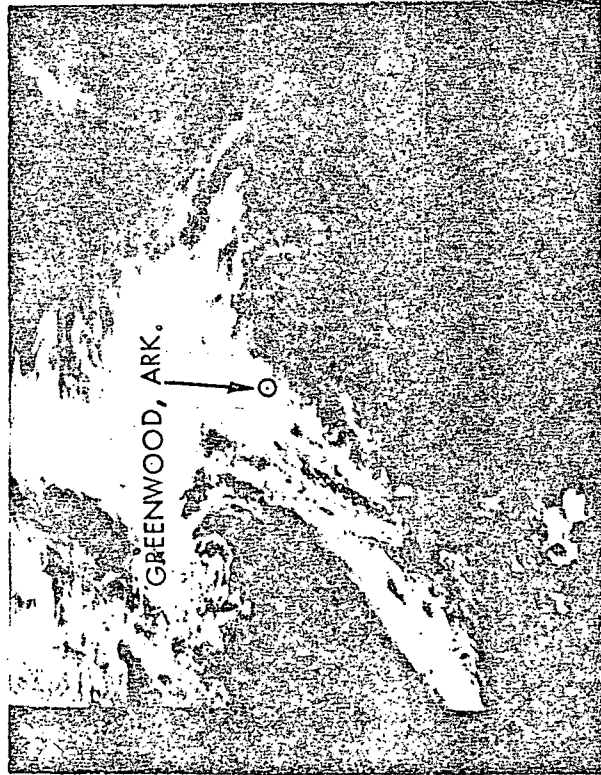
as shown in figure SC 70-224. Control of the sensors and reception of the data is effected by the NOAA operational data collection station at Wallops Station, Virginia, from which it is transmitted by land-line to the National Environmental Satellite Center at Suitland, Maryland. At Suitland, this data is used in normal satellite based weather forecasting.

As a consequence of the ATS 1 and 3 results, the first operational synchronous orbit satellites (SMS) have been approved and will be launched by NASA for NOAA starting in 1972.

It is planned to continue our meteorological observation program with a high resolution radiometer on ATS-F and a combination radiometer/sounder on ATS-G. The radiometer will provide day-night coverage of atmospheric motion over the Earth's disc and the sounder will provide vertical profiles of temperature and moisture distributions. With ATS-F located over Africa and ATS-G over South America, almost two-thirds of the Earth's equatorial region can be monitored either continuously or as desired.



3:13 PM CST



ELECTRONIC ENLARGEMENT

APPLICATIONS TECHNOLOGY

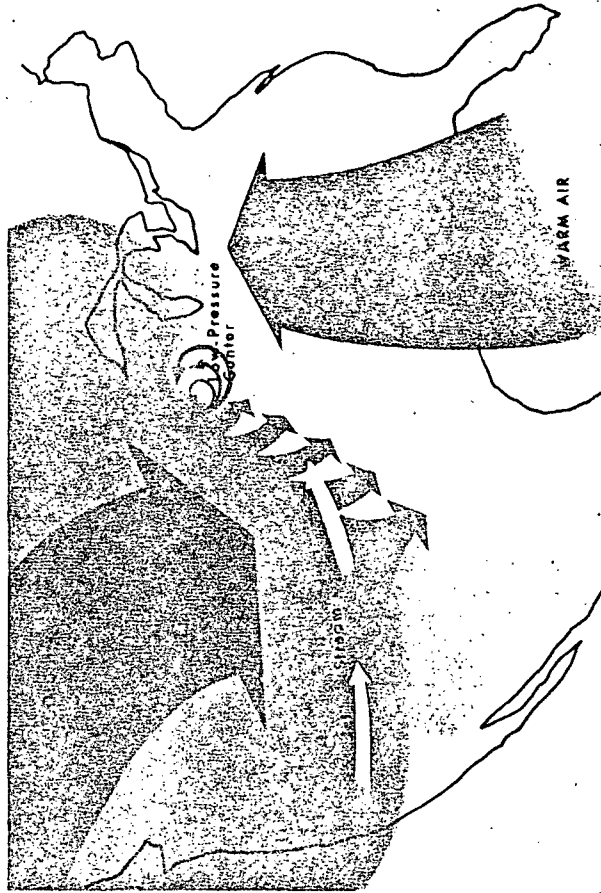
SATELLITES

TORNADO ANALYSIS

ATS III PICTURE

APRIL 19, 1968

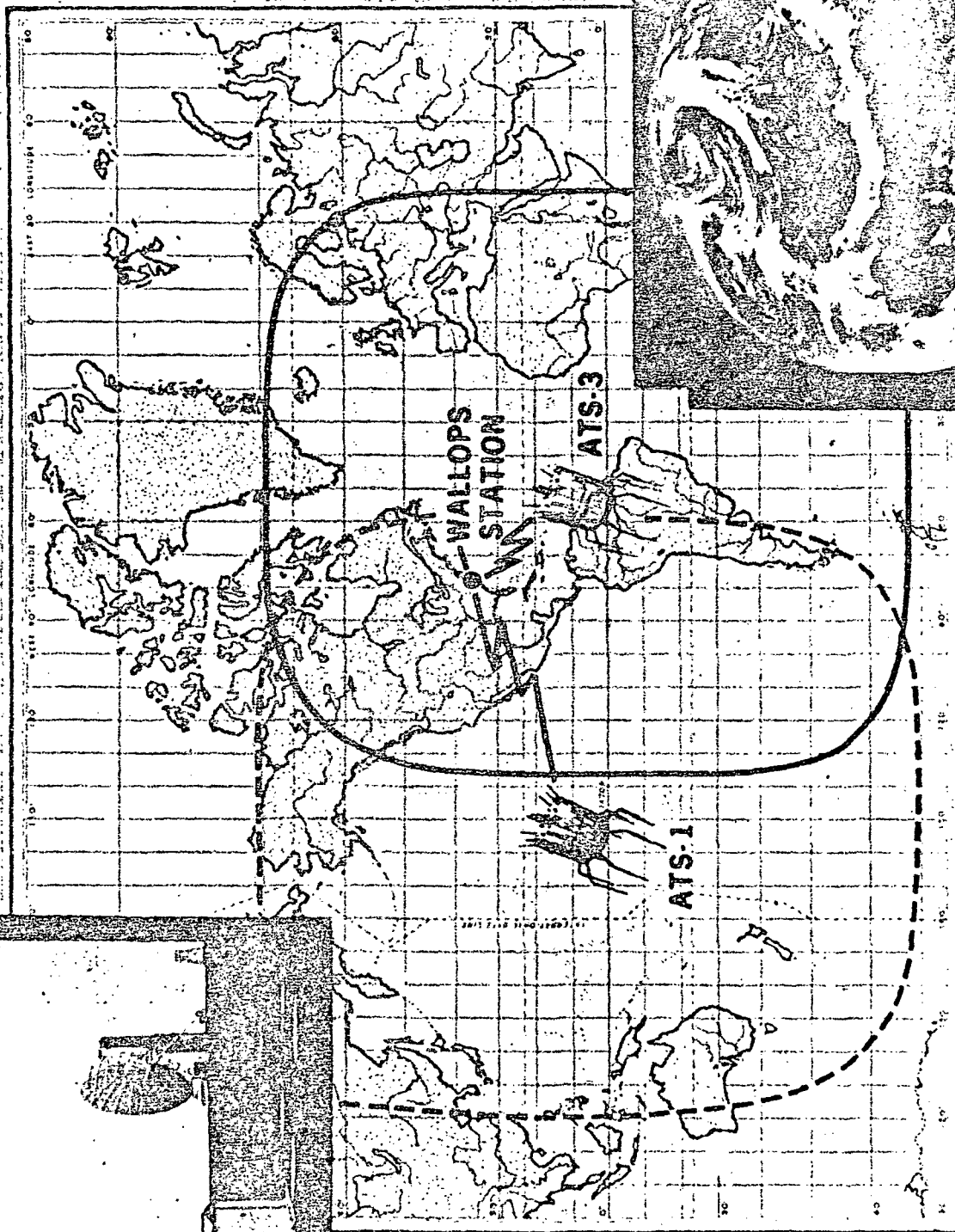
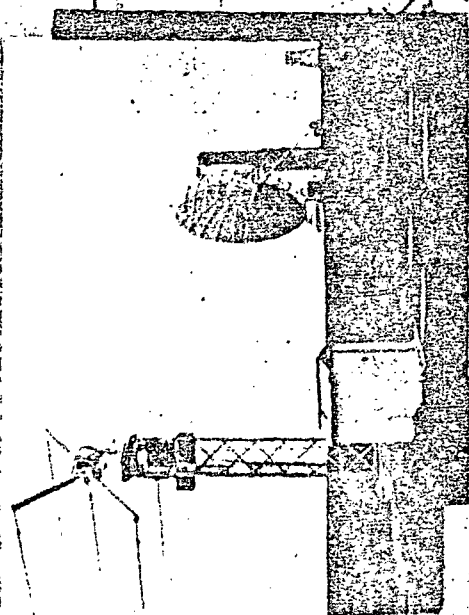
DURING TORNADO PRODUCING CONDITIONS



CHARACTERISTIC TORNADO SITUATION

COMMUNICATIONS PROGRAMS NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION USE OF ATS-1 & 3

REDUCES NASA GROUND STATION LOADING



NOT REPRODUCIBLE